



Parabolic Flight Campaign September 2012

Campaign Dates: September 6-14, 2012

Total payloads: 6

Parabolas: Zero G

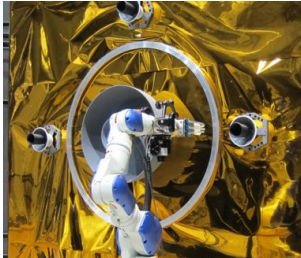


#	Title	PI/Organization
1	Autonomous Robotic Capture	Brian Roberts NASA Goddard Space Flight Center
2	Telemetric Biological Imaging	Robert Ferl, Anna-Lisa Paul University of Florida
3	Monitoring Radiation-Induced DNA Degradation	Howard Levine NASA Kennedy Space Center
4	Microgravity Multi-Phase Flow Experiment For Suborbital Testing (MFEST)	Kathryn Miller Hurlbert NASA Johnson Space Center
5	Microgravity Effects of Nanoscale Mixing on Diffusion Limited Processes Using Electrochemical Electrodes	Carlos Cabrera University of Puerto Rico
6	Effects of Reduced and Hyper Gravity on Functional Near-Infrared Spectroscopy (fNIRS) Instrumentation	Greg Adamovsky NASA Glenn Research Center



Autonomous Robotic Capture of a Free-Floating Payload in Near-Zero Gravity

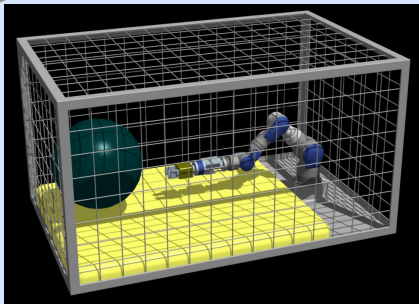
STATUS QUO



- Current ground simulations of on-orbit autonomous robotic capture do not adequately model the small-scale 3D contact dynamics between a robot and a satellite
- Some 2D and large-scale/low-bandwidth 3D simulations have been performed



NEW INSIGHTS



NASA's parabolic aircraft provide a unique opportunity to collect data in a zero-g environment in order to advance the fidelity of ground simulations.

MAIN ACHIEVEMENT:

Autonomous robotic capture technologies are being developed to advance the state of robotic servicing technology. A test cage will be flown containing a robotic arm and a free-floating mock satellite that will be autonomously captured.

HOW IT WORKS:

The robot will be fixed to the cage, which will be fixed to the aircraft. During each zero-g period, the mock satellite will be released so that it is free-floating within the cage. The robot will then try to track and grapple the mock satellite using its onboard sensing. A metrology system will independently measure the motion of the arm and mock satellite.

LIMITATIONS:

Each parabola provides only 25 s of zero-g to setup the system and perform capture

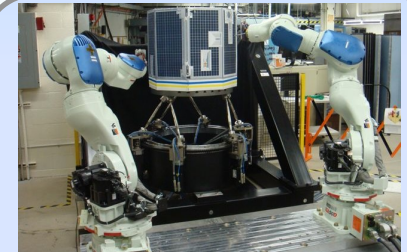
EXPECTED PERFORMER:

NASA/Goddard Space Flight Center: Robot control
West Virginia University: Sensing algorithms
U.S. Naval Research Lab: Metrology system
Yaskawa America, Inc: Robot manufacturer

SCHEDULE:

June-July:	System development, I&T
July:	Zero-g testing
July-Sept:	Improvement and validation of ground simulations

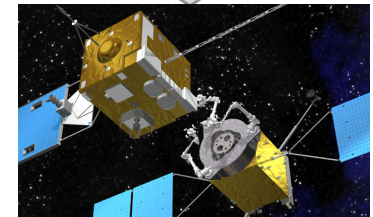
QUANTITATIVE IMPACT



- Motion data for the robot and mock satellite will be recorded to replay on ground simulation platforms
- Contact dynamics data will be gathered to validate ground simulations
- Robot sensing data will be captured to further refine capture algorithms

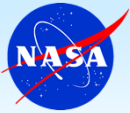


END-OF-PHASE GOAL



Data collected will advance ground simulation fidelity and help NASA address the following RTA Technical Areas: 4.1) Sensing and perception 4.3) Manipulation 4.6) Autonomous rendezvous and docking

These zero-g tests will provide critical data to advance ground simulations which are key to enabling reliable on-orbit robotic satellite servicing



Telemetric Biological Imaging -12P

Problem Statement

- There is currently no flight-ready biological imaging technology proven for the parabolic flight environment.
- This flight opportunity will demonstrate imaging hardware functionality in low and elevated gravity environments.
- Potential users of the matured technology include biology researchers and medical professionals interested in the parabolic flight realm, as well as the suborbital flight community

Technology Development Team

- PI Contact:
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- NASA Contact:
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Proposed Flight Experiment

Experiment Readiness:

- September 2012

Test Vehicles:

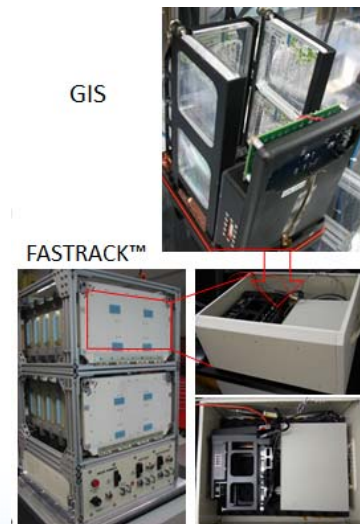
- Parabolic aircraft

Test Environment:

- Previously flew on Flight Opportunities Program parabolic flights in September 2011

Test Apparatus Description:

- Test apparatus and operator interfaces are incorporated into FASTRACK™. The GIS imager is loaded into a FASTRACK middeck locker drawer.



Technology Maturation

- Improved software interface. Full functionality during flight. Better thermal management. Clearer images.
- Provide clear images based on parabolic activation of gene activity.
- Technology maturation deadline is for deployment on suborbital and parabolic science.

Objective of Proposed Experiment

- Biological samples will be imaged in real time during the parabolic flights.
- Fluorescent images will be compared to biochemical data collected during the flight from parallel samples
- Expected flight data will evaluate the effects of the parabolic flight on the performance of the imager and on the gene expression of the biological samples.



Real-Time Instrumentation for Monitoring Radiation-Induced DNA Degradation (RTDNA)

Problem Statement

- There is currently no flight-ready DNA melting analysis hardware available in a low-G environment. Hardware will be used to determine, in real time, the level of DNA damage caused by radiation in the spaceflight environment.
- This flight opportunity will demonstrate hardware functionality in low and high gravity environments.
- Potential users of the matured technology include ISS space biology researchers and medical professionals on Earth.

Technology Development Team

- PI Contact:
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- Funding Organization:
Office of Chief Technologist,
NASA

Proposed Flight Experiment

Experiment Readiness:

- September 2012

Test Vehicles:

- Parabolic aircraft

Test Environment:

- Previously flew on Flight Opportunities Program parabolic flights in September 2011

Test Apparatus Description:

- Test apparatus and operator interfaces are FASTRACK™ plus a free-float apparatus containing the RTDNA hardware. FASTRACK™ will supply power to the free-float apparatus. The free-float apparatus will melt DNA solution in an enclosed microfluidic channel device. Fluorescent images will be taken as the DNA melts. Data will consist of the fluorescent images and accelerometer values, correlated to real-time flight progression and any start/stop changes in DNA fluid pumping. The RTDNA hardware will be unpowered during takeoff and landing.



Technology Maturation

- Technology currently TRL4
- TRL5 reached following parabolic flights by proving the following technologies:
 - DNA solution pumping
 - Produce thermal gradient
 - DNA imaging
- TRL6 achieved by future Nanosatellite or NanoRacks flight

Objective of Proposed Experiment

- DNA will be melted to physically separate the two strands of DNA in the double helix.
- Fluorescent images of the melted DNA will be acquired to monitor the DNA's transition from double-stranded to single-stranded.
- Expected flight data will evaluate the effects of the reduced gravity environment on fluid function and thermal gradients within the RTDNA hardware.

List the applicable Technology Areas addressed by your technology: www.nasa.gov/offices/oct/home/roadmaps



Multi-Phase Flow Experiment for Suborbital Testing (MFEST)

Problem Statement

- Multi-phase flow systems (like those used for water processing) are gravity sensitive; MFEST is designed to operate under Earth-normal and near-zero gravity; testing will evaluate system stability throughout the flight profile to support future space missions.
- Suborbital flight would allow long-duration, continuous operational testing with variable gravity over a wide range.
- NASA and other government agencies (e.g., DARPA), and commercial companies (e.g., ACT, Inc. (see below).

Technology

Development Team

- PI: Kathryn Miller Hurlbert, Ph.D.; NASA JSC Crew and Thermal Systems Division; katy.m.hurlbert@nasa.gov
- Sponsor: NASA JSC Engineering Directorate/Steve Stich; j.s.stich@nasa.gov
- Partner: Space Engineering Research Center (SERC) at Texas A&M; Charles Hill; hill@tamu.edu
- Expected Partner: Advanced Cooling Technologies, Inc.; Mike Ellis; Mike.Ellis@1-act.com

Proposed Flight Experiment

Experiment Readiness:

- Experiment being prepared for September parabolic flight campaign. Targeting to be ready for Suborbital Flight in 2013.

Test Vehicles:

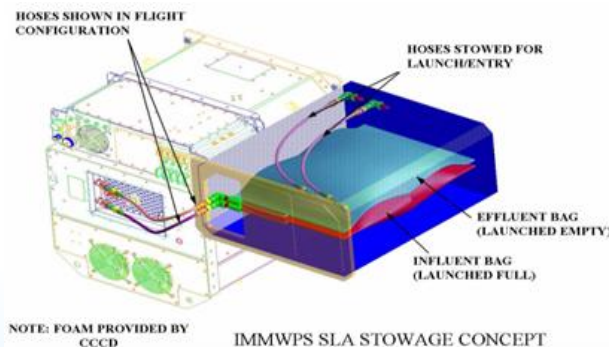
- Parabolic aircraft for early checkout of payload and data collection. SpaceShip Two requested for suborbital testing, due to size of payload.

Test Environment:

- Payload has not flown as an integrated test package prior, but component(s) like the multi-phase flow separator have been flown successfully on parabolic aircraft to obtain basic flow data (e.g., pressure drop). Requesting both parabolic and suborbital flight, to allow longer-duration, continuous operational testing with variable gravity over a wider range, for both the unique separator concept and two-phase flow system design.

Test Apparatus Description:

- MFEST is a modified version of a previous flight experiment that was originally designed for the Space Shuttle mid-deck, but was never flown due to mass, crew time, and other mission limitations. A paper by Hurlbert et al., (2002) fully describes the hardware completed, tested, and certified as ready for flight nearly a decade ago. The experiment is expected to operate autonomously through the flight.



Technology Maturation

- The current MFEST is TRL 5, but the hardware will require checkout, refurbishment, and/or modification prior to suborbital flight.
- Suborbital testing will advance MFEST to TRL 6/7, as it will provide testing in the relevant future mission environment.

Objective of Proposed Experiment

- The primary objectives of the parabolic flight campaign for MFEST are to conduct precursor testing of the integrated experiment in a simulated environment, to checkout the hardware and procedures prior to suborbital flight, and to obtain basic flow systems data in preparation for the suborbital flight(s).
- The primary objective of the suborbital flight for MFEST is to conduct a pathfinder, suborbital flight experiment that focuses on two-phase fluid flow and separator operations through a representative launch, suborbital, and entry profile.
- The test program would verify functional operations of the multi-phase flow system and unique separator for a relatively long duration with variable gravity, in support of future space vehicle designs and missions.

The proposed experiment can be applicable to technologies designated in multiple draft OCT Space Technology Roadmaps: TA02, In-Space Propulsion Technologies; TA03, Space Power and Energy Storage; TA06, Human Health, Life Support and Habitation Systems; TA07, Human Exploration Destination Systems; and TA14, Thermal Management Systems.



Microgravity effects of nanoscale mixing on diffusion limited processes using electrochemical electrodes

Problem Statement

- The test/design of the electrodes is directed towards optimizing the Electrochemical Ammonia Reduction (EAR) subsystem, critical to the Forward Osmosis Secondary Treatment (FOST) system. This project is covered by the Office of the Chief Technologist Next Generation Life Support project.
- In previous research by Micro-G CANM1 the electrochemical oxidation of ammonia in microgravity using different nano-materials led to 20-65% decrease in the catalytic current. This flight opportunity is to test mitigation approaches to improve electrode technology and better understand the phenomenon.

Technology Development Team

Principle Investigators: Dr. Carlos Cabrera, University of Puerto Rico (UPR), carlos.cabrera2@upr.edu; and Michael Flynn, NASA Ames.

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Organizations involved: Department of Chemistry, NASA URC Center for Advanced Nanoscale Materials, UPR & NASA ARC.

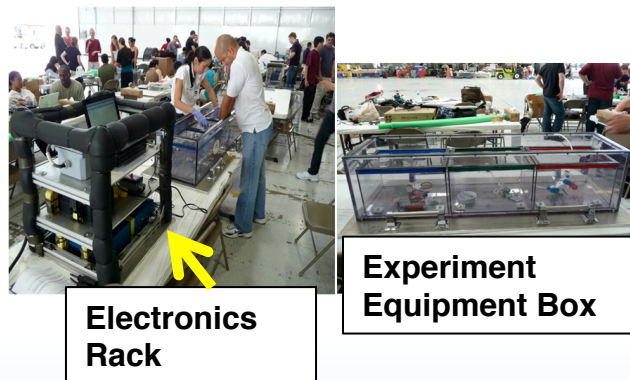
Proposed Flight Experiment

Experiment Readiness: Experiment will be ready for flight for the September 2012 campaign.

Test Vehicles: Parabolic Flight

Test Environment: The equipment flew on June 2011 via the 2011 NASA Microgravity University / Minority Institution Flight Week Program (Proposal Number 2011-25329) and now it's been approved via proposal NOCT110 Call #3.

Test Apparatus Description: The Electrochemical Microgravity Laboratory (EML) is comprised of 2 major components: (a) Electronics Rack (ELR) to control the electrochemical operation and (b) Experimental Equipment Box (EEB) double contained Makrolon™ box safely containing the electrochemical cells (triple containment in overall).



Electronics Rack

Experiment Equipment Box

Technology Maturation

- The proposed research is TRL 5.
- Component validation in a microgravity environment is imperative. The design of the electrodes for the EAR is critical to its correct sizing and integration to the FOST system. The EAR has delivery date of Jan 2013. Without this flight opportunity on Sept 2012 this milestone will not be met.

Objective of Proposed Experiment

Objectives: Test approaches developed to mitigate the decrease in catalytic current by: (1) inducing hydrodynamic turbulent mixing at three different flow rates; (2) the reengineering of the electrode geometry and pore structure by: (a) utilizing bulk electrolysis and (b) changing the pore size employing three different mesoporous carbon supports (average diameters of: 64, 100 and 137 Å).



Effects of Reduced and Hyper Gravity on Functional Near-Infrared Spectroscopy (fNIRS) Instrumentation

Problem Statement

- fNIRS quantifies neural activations in the cortex by measuring hemoglobin concentration changes via optical intensity. This depends on probe-skin coupling which is highly susceptible to motion.
- The lack of reliable and self-applicable headgear robust to the influence of motion artifact blocks its operational use in aerospace environments. It is difficult to separate changes due to functional activation from changes due to motion.
- Both NASA's Aviation Safety and Human Research Programs may be potential users of this technology.

Technology Development Team

- PI: Angela Harrivel, PhD Cand.
Co-I: Grigory Adamovsky, PhD
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- this effort is supported with funding from the Vehicle Systems Safety Technologies Project, contact Amy Jankovsky,
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Proposed Flight Experiment

Experiment Readiness:

- the experiment will be ready to meet deadlines for flight in September, 2012.

Test Vehicles:

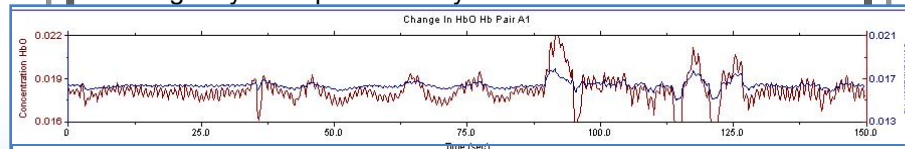
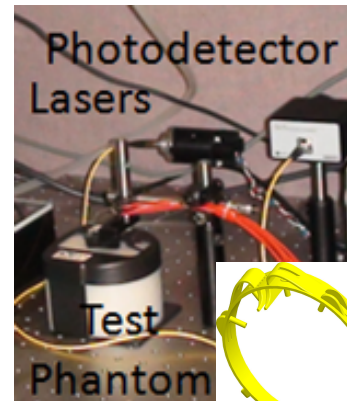
- 727 parabolic aircraft

Test Environment:

- The experiment has not previously flown in micro-gravity environments.
- We request microgravity conditions. Martian, lunar and 1.5g conditions desired.

Test Apparatus Description:

- Laser light will be delivered to and collected from optically scattering phantom material via optical fibers held in place by headbands mounted on the test material (pictured above - two probes per headband). Optical and electrical components will be mounted on a breadboard bolted to a rig (previously flown).
- A pressure sensor at one probe, and photodetectors at the bilateral probe, will be used to collect data throughout changes in the mechanical environment and microgravity conditions, for various headgear strap tensions.
- Operator interface will be via laptop computer for data collection, and will require adjustment and reconfiguration to achieve test matrix objectives during some high-g portions of the flight by an experienced flyer.



Technology Maturation

- the headgear is TRL 4 in 2012
- to achieve TRL 5 in 2013:
 - iterate and expand headgear prototypes and data processing with 2012 flights
- advance electronics to provide frequency-domain fNIRS
- collect functional data in a relevant aviation microgravity environment with human subjects performing an attentional task
- plan to achieve TRL 6 in 2014 with subsequent integration into a more complex cognitive state predicting system.

Objective of Proposed Experiment

- These flights aim to inform headgear design and data processing methods, and verify instrumentation to prepare for IRB approval for future human subject tests.
- The flight data will include dynamic optical and mechanical measurements. Characterization of mechanical contributions to the optical signals will allow the determination of headgear design parameters to minimize contamination, while allowing their identification and removal.